remedy we have in our own hands: either mix for ourselves, or buy subject to analysis; but to properly understand the several terms of an analysis, a course of practical instruction in a laboratory is necessary.

"It is indeed surprising that in a country where the practice of agriculture is carried to such a high degree of perfection, and where it is one of the chief sources of wealth, and is besides the means of employing such an immense amount of labour and capital, so little should be done towards the scientific education of those engaged in its pursuit. As a rule, agriculture is practised almost exclusively under the guidance of a slowly-earned experience, and mere traditional principles and habitual routine, without those engaged in it having any appreciation of the phenomena and natural laws which govern the growth and production of animal and vegetable food, the first necessaries of man.

"The success we have already arrived to in agriculture is, I believe, more mechanical than scientific. Drainage, steam culture, and a liberal use of capital and labour, are amongst the chief causes; but now that chemistry in its relation to artificial manures is taking such a prominent position, it is of the first importance that the future generation of farmers should have such a general knowledge of science as will enable them to correctly appreciate the value and properties of the various compounds offered by the too numerous chemical manure makers.

"I cannot imagine a more dangerous, unfortunate, and lamentable position for any person to be in, whilst in the practice of his business, by which he hopes to gain his bread for himself and family, than being entirely dependent on the scientific skill and integrity of another man; or that his capital, time, labour, care, and hopes should be in many cases completely out of his own control. Such a state of things cannot—must not—last.

"What I propose to do to correct this state of things is this—at a very moderate cost to give to an agricultural pupil a six or twelve months' course of scientific education and practical laboratory teaching after he has left his regular school; and I will engage that any boy of average ability, at the expiration of this time, shall have such a knowledge of all the materials employed in the compounding of chemical manures as will enable him to dictate what should be used without the interested interference of the manure maker. He shall besides have such an insight into the science and laws of chemistry as to make the reading and future study of scientific agriculture not only perfectly easy, but a delightful and intellectual employment.

"To carry out this important object three conditions are necessary—a good qualified teacher, a laboratory, and pupils. The first could be had for a very moderate salary; the laboratory, with the necessary instruments and materials, would involve no serious outlay; the third condition, the pupils, gives rise to this question—Would farmers send their sons to supplement their previous education by a six or twelve months' practical scientific instruction? The want of such knowledge amongst the present generation must be so strongly felt that I believe they would be too glad to have the opportunity, especially if they knew that probably a moderate fee would more than pay the costs.

"The site of the laboratory might be anywhere—a small country village would in many respects offer advantages superior to a market town. The cost of erecting or hiring a building suitable for a laboratory, together with the instruments and materials, should be raised by subscription. The pupils' fees would, I have no doubt, pay all other charges, so that when once established it would ever after be self-supporting.

"I am aware that certain schools exist where agricultural science is professedly taught, but I consider such a combination as almost waste time, the two kinds of teaching cannot be well carried on together, and what is most important, the mind must arrive to a certain maturity before it can grasp with sufficient reasoning power the beautiful and wonderful phenomena arising out of laboratory practice.

"If the foregoing observations should be thought worthy of the serious consideration of persons interested in agriculture, I shall indeed be glad to receive any communications or suggestions in promotion of the object of this letter; and if our members will support this object by the subscription of a sum equal to only a tenth of one year's savings effected through the agency of our association, I will devote myself most earnestly to establish a school laboratory in this village that I trust may serve as a model and example to be followed by many other localities in Great Britain.

"I shall certainly not ask a single member of our Association to do that which I am not prepared to do myself. My consumption of phosphate manure—of course, I buy no mixtures or nostrums—is about twenty tons a year; and previous to the formation of our Association I paid to the most respectable makers 6*l.* 10*s.* per ton for manure, containing 25 per cent. of water. The percentage of soluble phosphate was entirely a matter of speculation. According to an elaborate report of Anderson and Way, from an analysis of 171 samples, the average per-centage of soluble phosphate at that time was 15 per cent., and a ton of this manure was valued by these chemists at 7*l.* 5*s.* per ton. Therefore, if a 15 per cent. manure was worth 7*l.* 5*s.* a 26 per cent. manure would be worth 12*l.* 10*s.*; but our Association price for the 26 per cent. manure is now 3*l.* 18*s.* per ton in bulk, delivered free at any station in Lincolnshire, with a further advantage of a watchful system of analysis, free of any cost, to ensure quality and dry condition.

My saving on these calculations would be 8*l.* 12*s.* per ton, or a total of 172*l.* on a consumption of twenty tons yearly. I state facts just as they are recorded by the most eminent chemists, and every farmer will believe me when I say that a very large proportion of the manure sold at that time had little or no value whatever, consisting as it did of *dried mud and road scrapings*, flavoured with a little gas water just to flatter the olfactory nerves of the wise and cautious farmer of that period. A tenth of 172*l.* would be 17*l.* 4*s.* for my contribution, but my requirements are much more modest. I think, therefore, I had better leave every member of our Association to form his own estimate of what he should contribute, suffice it to say that in the first instance the only contribution I ask for is a free and unprejudiced opinion as to the necessity and desirability of what I have in view, viz., the formation of a laboratory, in which agricultural chemistry shall be taught at small cost, in a short time, and in a practical way, to pupils who have received an ordinary education.

"I have only alluded thus far to the material advantage to be derived from a brief course of scientific instruction. Allow me, in conclusion, to quote the language of one of the best and most highly gifted of our chemical philosophers as to its moral influence. The late Dr. Faraday says:—'I do think that the study of natural science is so glorious a school that with the laws impressed on all created things by the Creator, and the wonderful unity and stability of matter, there cannot be a better school for the mind.' Vain and foolish ideas, the fruit of ignorance, cannot be uprooted and destroyed by violence, the natural and more gentle method must be adopted, what in chemistry is called the law of substitution; the mind must be fertilised by knowledge, then truth and useful ideas will take the place of error and ignorant conceits. It is the absence of the exercise of the higher and intellectual faculties that leads so often to vacuity of the human mind, and the consequent indulgence in grosser and more material excitements, injurious alike to body and mind. A better form of education would eradicate the greatest of all human enemies—Ignorance and Intemperance.

"W. Little

"The Hall, Heckington, Lincolnshire"

Degrees for Engineering Students at the University of London

In one of your Notes for May 11 you refer to the failure of a motion which I brought before Convocation of the University of London at its recent meeting, to the effect that it was desirable that Greek should cease to be a compulsory subject at the matriculation examination. I have no wish to trouble your readers with a discussion of this subject, because it has been already so well ventilated in various quarters, and general opinion with regard to it has so nearly crystallised into form in other convocations than that of the University of London, that I have no doubt that the Senate of the University will ere long see the absolute necessity, if the University is to be kept *en rapport* with the scientific culture of the country as it has been hitherto, of adopting the course which I have urged, and the expediency of which has been endorsed by some of the highest educational authorities. The rejection of my motion is not the first illustration that Convocation has given of the highly conservative tendencies of many of its members, and of their incapacity to appreciate the liberal spirit in which the University was founded; and I am quite content to leave the case as it stands, with the remark made by one of old under similar circumstances—

> Victrix causa Diis placuit, sed victa Catoni.

I shall, however, be glad if you can favour me with a little

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space in your columns to air another subject which I also brought before Convocation, with, I am sorry to say, equal want of success, and that is the desirability of modifying the examinations for the degree of Bachelor of Science by omitting the biological subjects, so as to induce engineering students to take it. At present the biological subjects required for the degree, viz., Zoology, Botany, Physiology, and Organic Chemistry, are so entirely foreign to the studies and requirements of such students that in most cases it is scarcely practicable, even if it were desirable, for them to travel so far out of their regular line of work, for the purpose of getting them up for the Bachelor of Science examination. Such a course would be precisely analogous to that which is now prescribed for medical students proceeding to their M.B. degree, who are required to take up those subjects of the B.Sc. examination which are cognate to their routine of study, and who then branch off to those of a purely professional character.

Only two objections were urged in Convocation against this scheme which are worth consideration. The first was that it would tend to lower the standard of the degree by diminishing the comprehensiveness of the examination. In order to meet this objection I suggested that candidates not wishing to take up the biological subjects should be required to substitute for them others of a mechanical nature, such as Applied Mechanics, Engineering and Architectural Construction, and Geometric Drawing, which, as all who have had any experience in teaching them know, are quite as capable of being made efficient educational tests as those which they would replace. The second objection was, that to make such a change would be equivalent to instituting a degree in engineering. That this would be the practical result of the suggested alteration I am prepared to admit, and it is the object which I had distinctly in view in proposing it. What there was in the suggestion to provoke the unconcealed opposition of so many of the members of Convocation, I am a loss to imagine, unless it was the illusion that the profession of engineering is a less scientific one, and the education of its members less worthy of being encouraged, than that of the professions of law and medicine, to which so large a proportion of the London graduates belong.

For my own part, it seems to me a scandal of no mean gravity that, whilst the practice of that profession requires intellectual qualifications of the highest order, and a scientific training of the widest kind, no means should exist in this country whereby either the public should be provided with any guarantee that those who practise it possess either of these qualifications, or its practitioners themselves should be enabled to give evidence of the fact of their own accord. I do not know of any department of education in which the University of London could, at the present time, do more service than in this, and, I trust, there are men in its Senate, who, with more breadth of appreciation than the majority of Convocation, will give the matter their earnest attention.

FRANCIS T. BOND

Hartley Institution, Southampton

Mechanical Equivalent of Heat

I AM afraid your publication, without adding the date, of my letter last week (which I only saw this morning) puts me in a false position in regard to Dr. Joule, inasmuch as it appears to ignore a correspondence of mine with him, which took place between the time that letter was written (now a long time since) and the time of your publishing it.

In that correspondence I allowed that Dr. Joule's theory remained the same in its main features, though I thought he virtually retracted one statement which I had particularly argued against. Dr. Joule, however, did not allow he had made any alteration.

He also informed me that a paper of mine had been read at the meeting of the Manchester Literary and Philosophical Society, in which I showed (as I believe) in a detailed examination that his theory was inconsistent with the results, both of his own and of M. Favre's experiments. Dr. Joule also kindly communicated to me the substance of the reply which he had made, but I have not seen either in print. Of course the question is one of facts; are facts consistent with the new laws of thermodynamics as supposed to have been established during the last twenty years? Tait, in his preface to his Thermodynamics, says: "The subject is one of vast importance, but very few indeed are yet acquainted with even its most elementary facts; and by many of these it is not yet accepted as true." These laws, therefore, can scarcely yet be put on a level with Newton's laws, even if they should be shown to be consistent with facts, which, at least in their present form, I believe to be impossible.

H. HIGHTON

May 18

MR. HIGHTON'S letter in NATURE is almost identical with his communication to the *Chemical News*. My answer is similar to that which I sent to the latter publication, viz., that the object of my paper in the Proceedings of the Literary and Philosophical Society was simply to place the theory of the electro-magnetic engine in a form which might prove useful to those who had not worked on the subject, and not in any respect to withdraw the reasonings in what Mr. Highton is good enough to term my "famous paper." Mr. Highton handsomely acknowledged the justice of my note to the *Chemical News* in a letter addressed to me on the 28th ult.

JAMES P. JOULE

Optical Phenomenon

IN reading over Prof. Clerk Maxwell's paper on Colour in NATURE (Vol. iv. p. 13), I was reminded of the following, to me, curious phenomenon which was seen by me on several occasions in the summer and autumn of 1859.

Whilst standing before a black board, making geometrical figures in white chalk, I was struck by one side of each chalk line appearing blue, the remaining half retaining its proper white. The cause was at once evident to me, for I found that the sun shone fully upon one eye, but not upon the other. By closing the eye upon which the sun shone, the chalk marks appeared wholly white. Opening the eye again, the half blue, half white marks appeared; then closing the eye upon which the sun did *not* shine, the whole of the marks appeared a pale blue, scarcely so deep in colour as when in contrast with the white. By squinting, or forcing the eyes to see double, two sets of marks appeared, the one set all blue, the other wholly white.

Subsequently, with the sun upon both eyes, the whole of the marks were blue; whilst upon another occasion, when the sun shone very fully upon both eyes, only the white marks were evident; but shading the eyes by the hand, and allowing a ray to fall upon one eye, the usual half blue half white lines appeared.

On every occasion that I tried the experiment I met with the same results, and when I looked away a beautiful orange-coloured spot—the complementary colour of the blue, I suppose—appeared for some time wherever I looked. What is the cause why only the blue rays were visible? and why blue rather than red or yellow?

THOS. WARD

Yellow Rain

THE following notice will perhaps be of some interest to the readers of NATURE. In December 1870, after a heavy rain at Rosario de Cucuta (New Granada), a great many small round specks of a yellow clayish substance were found on the leaves of plants that had been exposed to the rain. A sample of this substance was sent to Dr. A. Rójas, of this town, who forwarded it to me in order to examine it under the microscope. It proved to be composed almost entirely of a species of *Triceratium*, and another of *Cosmarium*, which must have been carried away by a violent storm from their lacustrian abodes.

Caracas (Venezuela), April 1871

A. ERNST

The Irish Fern in Cornwall

MY first impulse, on reading the note on this subject in NATURE for the 4th of May, was to apologise to Mr. Dymond for having caused him so much regret by making known a Cornish station for this fern. This first impulse was however checked by the reflection that something is due to the advancement of the study of distributive botany; and I could scarcely have expected even Mr. Dymond to place any very great degree of confidence in my bare assertion, unaided by any reference to localities.

Now that I have done the mischief and made known that the Trichomanes is a Cornish plant, and have been corroborated by Mr. Dymond, it would be interesting to know whether the writer of the note on this fern in the Cheltenham Natural History Society's report found his specimen at the same place, *i.e.* at St. Knighton's.

EVERARD F. IM THURN

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